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(54) FUEL CELL AND ITS OPERATING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To minimize the apparatus to be arranged around a cell and a device to simplify the structure by constituting a separator having a fuel gas passage and an oxidizer gas passage arranged therein so as to be usable also as a cooling plate.

SOLUTION: The fuel cell 7 of a solid polymer type fuel cell 1 comprises a solid polymer electrolytic film 2a conductive and air-permeable fuel electrode film 3 and oxidizer electrode film 4 arranged on both sides of the solid polymer electrolytic film 2a fuel gas separator 5 having a fuel gas passage for supplying a gas to the electrode film 4 and discharging the gas from the electrode film 4and

an oxidizer gas separator 6 having an oxidizer gas passage. Further a heat pipe 9 having a radiation fin 11 is provided at the end of the oxidizer gas separator 6. In this case the heat pipe 9 with the radiation fin 11 is connected to one side of the substantially rectangular oxidizer gas separator 6.

CLAIMS

[Claim(s)]

[Claim 1] A fuel electrode film (3) and an oxidant electrode film (4) which combine solid polyelectrolyte membrane (2) and conductivity arranged to both sides of this solid polyelectrolyte membrane (2) and breathability. Supply gas to this fuel electrode film (3) and an oxidant electrode film (4) and Or an electrode layer (3) in a solid polymer type fuel cell (1) which laminates two or more fuel cell cells (7) which comprise a separator for oxidant gas (6) which has a separator for fuel gas (5) and an oxidant gas passage which have a fuel gas flow route for discharging gas from (4) and constitutes a layered product. A fuel cell being the structure where said separator for fuel gas (5) and a separator for oxidant gas (6) have a heat pipe (9) and a fin for heat dissipation (11) was provided in this heat pipe (9).

[Claim 2] A separator for fuel gas (5) and a separator for oxidant gas (6) which have said heat pipe (9). The fuel cell according to claim 1 being the structure where have arranged a tube-like pipe in a metal plate which has conductivity and hydraulic fluid (10) which is a heat transporting medium was enclosed in this pipe.

[Claim 3] The fuel cell according to claim 1 wherein said heat pipe (9) is a structure which a chilling effect will reveal if it reaches more than constant temperature by enclosing inactive gas such as air and nitrogen gas with an inside at containers such as bellows (12).

[Claim 4] Make a fuel cell (1) generate by supplying fuel gas and oxidant gas and at the time of starting of a fuel cell (1) according to adiabatic efficiency of a heat pipe (9) while carrying out a rise in heat promptly by a fuel cell cell's (7) own generation of heat. An operating method of the fuel cell according to claim 1 to 3

emitting into the atmosphere reaction fever which the cooling function of a heat pipe (9) operates and is generated with a cell reaction via a heat pipe (9) when it becomes beyond temperature with a fuel cell cell (7).

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a fuel cell provided with the separator which comprises the cellular structure of the polymer electrolyte fuel cell which uses solid polyelectrolyte membrane as an electrolyte especially a heat pipe and an operating method for the same.

[0002]

[Description of the Prior Art] The composition of the conventional fuel cell is shown in drawing 4. Polymer electrolyte fuel cell 1' supplies gas to the fuel electrode film 3 and the oxidant electrode film 4 and pan which combine the solid polyelectrolyte membrane 2 and the conductivity allotted to both sides of this solid polyelectrolyte membrane 2 and breathability at that electrode layer. Or two or more fuel cell cells 7 which consist of the separator 6 for oxidant gas which has the separator 5 for fuel gas and oxidant gas passage which have a fuel gas flow route for discharging gas from an electrode layer are laminated every lamination number of sheets -- or the cold plate 8 which has a cooling-medium channel the fuel cell cell 7 and by turns is arranged and constituted.

[0003] In this fuel cell 1' in order to supply the oxidant gas which uses hydrogen as main fuels such as fuel gas or oxygen respectively to exhaust the reaction fever which generates heat when reacting electrochemically and to keep the temperature of the fuel cell cell 7 constant the cold plate 8 is arranged.

[0004] The conventional fuel cell system figure is shown in drawing 5. In the figure the pump by which 14 was connected to the fuel cell system and 17 was

connected to polymer electrolyte fuel cell 1' and 19 are the cooling systems similarly connected to fuel cell 1' and this cooling system 19 is connected to the water tank 20 via the cooling-circulating-water piping 18. 21 is a fuel part. In this fuel cell system 14 water is mainly used as a cooling medium. The cooling-medium channel was supplied by the power of the pump 17 grade and keeping constant the temperature of the fuel cell cell 7 shown in drawing 4 after it was cooled by the cooling system 19 for exclusive use or air cooling means etc. and the cooling medium used as the elevated temperature discharged from the cold plate 8 became low temperature it was again supplied to the cold plate 8 and it circulated through it.

[0005] Conventionally in such fuel cell 1' management etc. of the water which is the pump power for circulating equipment of the pump 17 for cooling said fuel cell cell 7 the cooling-circulating-water piping 18 the cooling system 19 for exclusive use or an air cooling means and a cooling medium and a cooling medium needed to perform maintenance. The separator which is a component member of the fuel cell cell 7 and the cold plate 8 were formed from the carbon which has conductivity and a manufacturing cost is expensive and the cost of equipment of a cooling system etc. also required that including material and a conversion cost and they had checked low cost-ization.

[0006]

[Problem to be solved by the invention] The pump for cooling a fuel cell cell in the conventional fuel cell cooling-circulating-water piping a cooling system for exclusive use or an air cooling means needs to be furnished. And since the manufacturing cost of a fuel cell cell is expensive a miniaturization and weight saving of equipment and low cost-ization have been prevented. For there to be a fault that the pump power for circulating a cooling medium is required and reduce the efficiency under power generation and management etc. of the water which is a cooling medium need to be maintenance worked to lessen the apparatus arranged around a fuel cell and equipment as much as possible and to have easy composition is desired.

[0007]The place which it was proposed in order that this invention might solve an aforementioned problem and is made into the purpose Equipment of the pump for cooling a fuel cell cell by considering it as the separator with which the fuel gas flow route and the oxidant gas passage have been arranged and the structure which served both as the cold plate cooling-circulating-water piping a cooling system for exclusive use or an air cooling means is unnecessary The pump power for circulating a cooling medium management of the water which is a cooling medium further etc. are not needed but the small size and the weight saving of equipment and low cost-ization are attained the efficiency under power generation is raised and maintenance control is easy and there is in providing a fuel cell obtained inexpensive and an operating method for the same.

[0008]

[Means for solving problem] To achieve the above objects the fuel electrode film 3 and the oxidant electrode film 4 which combine the conductivity by which this invention has been arranged to both sides of the solid polyelectrolyte membrane 2 and this solid polyelectrolyte membrane 2 and breathability Gas is supplied to this fuel electrode film 3 and the oxidant electrode film 4 Or in the solid polymer type fuel cell 1 which laminates two or more fuel cell cells 7 which comprise the separator 6 for oxidant gas which has the separator 5 for fuel gas and oxidant gas passage which have a fuel gas flow route for discharging gas from the electrode layers 3 and 4 and constitutes a layered product Said separator 5 for fuel gas and the separator 6 for oxidant gas have the heat pipe 9 and it is characterized by being the structure where the fin 11 for heat dissipation was formed in this heat pipe 9.

[0009] The separator 5 for fuel gas and the separator 6 for oxidant gas which have said heat pipe 9 arrange a tube-like pipe in the metal plate which has conductivity and are characterized by being the structure where the hydraulic fluid 10 which is a heat transporting medium was enclosed in this pipe.

[0010] By enclosing inactive gas such as air and nitrogen gas with the inside of a heat pipe at the container of bellows 12 grade if the radiator of said heat pipe 9

reaches more than constant temperature it will be characterized by being the structure which a chilling effect reveals.

[0011] As an operating method of the fuel cell of the above-mentioned composition, make the fuel cell 1 generate by supplying fuel gas and oxidant gas and at the time of starting of the fuel cell 1 according to the adiabatic efficiency of the heat pipe 9 while carrying out a rise in heat promptly by generation of heat of fuel cell 7 itself. When it becomes beyond temperature with the fuel cell 7, the reaction fever which the cooling function of the heat pipe 9 operates and is generated with a cell reaction is emitted into the atmosphere via the heat pipe 9.

[0012]

[Mode for carrying out the invention] This invention transmits heat to two or more fins for heat dissipation via a heat pipe and exhausts in the atmosphere the reaction fever which generates heat when using a heat pipe for the separator of a fuel cell and reacting to it electrochemically in a fuel cell. It is characterized [main] by keeping uniform the temperature of the fuel cell which laminates two or more sheets and constitutes a layered product.

[0013] The separator with which it comes to match a Prior art a fuel gas flow route and an oxidant gas passage and the cold plate which has a cooling-medium channel. Instead of the cooling system for exclusive use being arranged independently, respectively, the separator with which the fuel gas flow route and the oxidizer passage were allotted comprises a heat pipe. Two or more fins for heat dissipation are formed in said heat pipe and the hydraulic fluid which is a heat transporting medium is enclosed in a metal plate and it is considered as integrated structure and differs in that it has a chilling effect.

[0014] By thus the thing for which it serves both as the separator and cold plate with which the fuel gas flow route and the oxidant gas passage have been arranged in said fuel cell and a fuel cell is constituted as integrated structure. It becomes possible to make simple the apparatus arranged around a fuel cell and equipment like the fuel cell system 14 by this invention shown in drawing

3As a result in about 1/3 of equipment and capacity and weight a manufacturing cost becomes conventionally reducible [1/2] and maintenance control becomes easy and the small size and the weight saving of equipment and low cost-ization can be attained. By supplying fuel gas and oxidant gas the operating method of this invention **** fuel cell makes a fuel cell generate and emits into the atmosphere the reaction fever generated with a cell reaction via a heat pipe. By enclosing inactive gas such as air and nitrogen gas with a heat pipe at containers such as bellows and forming in the inside of a heat pipe At the time of fuel cell starting it has adiabatic efficiency a fuel cell cell is heated promptly shortening of warm-up time is aimed at when it reaches beyond temperature with fuel cell cell temperature and the heat pipe operates a chilling effect is revealed and the fuel cell which keeps the temperature of a fuel cell cell uniform by temperature control is provided.

[0015]

[Working example] Drawing 1 shows the exploded perspective view of the polymer electrolyte fuel cell 1 concerning one working example of this invention. Hereafter one working example of this invention is described using drawing 1.

The fuel electrode film 3 and the oxidant electrode film 4 which combine the solid polyelectrolyte membrane 2 and the conductivity allotted to both sides of said solid polyelectrolyte membrane 2 and breathability in this invention It has the separator 6 for oxidant gas which has the separator 5 for fuel gas and oxidant gas passage which have a fuel gas flow route for supplying gas to said electrode layer or discharging gas from an electrode layer The heat pipe 8 which has the fin 11 for heat dissipation at the end is formed in the separator 5 for fuel gas and the separator 6 for oxidant gas and the fuel cell cell 7 is constituted by these.

[0016] In this case the heat pipe 8 with the fin 11 for heat dissipation is connected to one [which makes a rectangle mostly] flank of the separator 6 for oxidant gas. ** arranged at the bottom -- the heat pipe 8 as the flank side of different another side with the same separator 6 for oxidant gas is formed in the separator 5 for fuel gas which makes a rectangle mostly. And two or more sheets of this fuel cell

cell 7 are laminated a layered product is constituted and the polymer electrolyte fuel cell 1 is constituted.

[0017] The heat pipe 9 used by this invention may give surface coating by vacuum evaporation etc. to the metal plate surface with the precious metals excellent in corrosion resistance. A tube-like pipe is arranged in the metal plate which has conductivity and the hydraulic fluid 10 which is a heat transporting medium is enclosed in this pipe. The metal thing excellent in the conductivity of aluminum, stainless steel, copper etc. and processability is used for the metal plate which has conductivity and the things excellent in corrosion resistance such as gold, silver, nickel, alumina alloy and titanium are used for surface coating. The Reason conductivity is needed for the heat pipe 9 of this invention is for electrically connecting between two or more fuel cell cells 7 in series.

[0018] The fin 11 for heat dissipation which processed the sheet metal is formed at the tip of the heat pipe 9 and by attaching two or more these it arranges so that heat transport can be performed easily. The water, ammonia, acetone and methanol system hydraulic fluid in which the hydraulic fluid 10 fitted the service temperature field of the fuel cell for conveying heat from a heat source by carrying out a phase change to a liquid from a gas from a liquid to a gas are used.

[0019] A cooling method of the heat pipe 9 is shown in drawing 2 (a) and (b). As for drawing 2 (a) drawing 2 (b) shows a cooling-shut-down state during a cooling operation. As a structure of the heat pipe 9 in a metallic pipe of a tube which hits a radiator of the heat pipe 9 it has a fixed pressure where a container of bellows 12 grade is inserted and which has the inactive gas 13 such as air and nitrogen gas in it and is enclosed. When evaporating pressure of the hydraulic fluid 10 which is a heat transporting medium of the heat pipe 9 becomes higher than a container pressure of bellows 12 grade with a rise in heat of the fuel cell cell 7 capacity which pushes up a container of bellows 12 grade and hits a radiator becomes large. It is cooled by the hydraulic fluid 10 used as a steam moving to this space and transmitting heat to the radiation fin 11 hydraulic fluid is condensed and it becomes a liquid and returns to a lower heating region in

accordance with a wall of the heat pipe 9 and a chilling effect is revealed.

[0020] Drawing 3 shows the solid polymer type fuel cell system 14 with which the fuel cell 1 concerning above-mentioned this invention was stored in the case of *****.

As shown in this figure the fin 11 for heat dissipation of the heat pipe 9 is enclosed by a duct forced cooling is carried out with the cooling fan etc. which were formed in the upper part of the duct and a chilling effect may be made to be acquired promptly. A figure Nakaya seal shows the flow of air. 21 is a fuel part.

[0021] On the other hand since the evaporating pressure of the hydraulic fluid 10 is lower than the gas pressure of the container of bellows 12 grade there is no space which emits heat to the fin 11 for heat dissipation at the time of the cooling shut down of the heat pipe 9 it accumulates heat and heats the fuel cell cell 7 promptly.

[0022] Thus the temperature of the fuel cell cell 7 rises and in the case of the polymer electrolyte fuel cell 1 of this invention when about 80 °C is reached the gas pressure of the container of bellows 12 grade can be adjusted so that the cooling may operate and temperature control of the fuel cell cell 7 can be performed for example the time of reaching a certain temperature.

[0023] Although the heat pipe 9 used for this invention changes with calorific value of a fuel cell For example supposing it performs temperature control of the fuel cell cell of the calorific value of 500W in the case of the polymer electrolyte fuel cell 1 of this invention The heat pipe 9 of a tube form 5 mm in diameter is arranged in the metal plate which has 5 conductivity and in the range 150 mm in length the fin for heat dissipation arranges a 10-mm-high thing at intervals of 3 mm and should just use it.

[0024] Next the operating method of the fuel cell cell in this invention is explained. By supplying the oxidant gas which uses hydrogen as main fuel such as fuel gas air or oxygen respectively the fuel cell was made to generate cell temperature is in the same temperature as environmental temperature at the time of fuel cell starting and the cooling effect which is a function of the heat pipe 9 has stopped. Since the hydraulic fluid 10 serves as a steam of high temperature high

pressure it circulates through it inside the heat pipe 9 with the reaction fever which generates heat when reacting electrochemically at this time and that steam pressure is lower than the gas pressure of the container of bellows 12 grade. There is no space which emits heat to the fin 11 for heat dissipation; heat is accumulated; the fuel cell cell 7 is heated promptly and temperature is raised. If the temperature of the fuel cell cell 7 reaches beyond a room temperature, the increase of activation of the catalyst in an electrode and cell reaction speed will increase. By the increase in this cell reaction speed, since the calorific value accompanying a reaction also increases, the temperature of the fuel cell cell 7 also rises rapidly.

[0025] Thus the temperature of the fuel cell cell 7 rises and the time of reaching a certain temperature in the case of the polymer electrolyte fuel cell 1 of this invention when about 80 °C is reached, the cooling effect which is a function of the heat pipe 9 operates, for example. Namely, the evaporating pressure of the hydraulic fluid 10 which is a heat transporting medium of the heat pipe 9 becomes higher than the container pressure of bellows 12 grade when about 80 °C is reached. The capacity which pushes up the container of bellows 12 grade and hits a radiator becomes large and the hydraulic fluid 10 cooled by the hydraulic fluid used as a steam moving to this space and transmitting heat to the radiation fin 11 is condensed and it becomes a liquid and returns to a lower heating region in accordance with the wall of the heat pipe 9. By making a chilling effect reveal by the circulation phenomenon of this hydraulic fluid 10, temperature control of the fuel cell cell 7 is performed. Thus the temperature of the fuel cell cell 7 under power generation can be kept constant by repeating the operation of the cooling effect of the heat pipe 9 and a stop.

[0026] Although this example shows the example using the heat pipe 9 of the tube form in which the fin 11 for heat dissipation was formed, this invention is not limited to this but it should just have the function of the heat pipe 9 excellent in thermal transport property in the metal plate which has conductivity.

[0027] Thus by using the heat pipe 9 for the object for fuel gas to which it comes to

allot the fuel gas flow route and oxidant gas passage which are this invention and the separators 5 and 6 for oxidant gas. As shown in drawing 5, equipment of the pump 17 for cooling the fuel cell cell 7, the cooling-circulating-water piping 18, the cooling system 19 for exclusive use, or a cooling method is unnecessary. The pump power for circulating a cooling medium, management of the water which is a cooling medium, further etc. are not needed, but the small size and the weight saving of equipment and low cost-ization are attained, the efficiency under power generation is raised, maintenance control is easy and the fuel cell obtained inexpensive can be provided.

[0028]

[Effect of the Invention] According to this invention compared with the conventional fuel cell, the miniaturization of equipment and low cost-ization are attained, the efficiency under power generation is raised, there are also no necessities such as maintenance control of cooling circulating water and the fuel cell which attains shortening of the time which starting takes can be provided.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a block diagram showing the structure of the fuel cell cell by one working example of this invention.

[Drawing 2] It is an explanatory view showing the details of the heat pipe structure used for this invention and heating and a cooling method.

[Drawing 3] It is a block diagram showing the fuel cell system using this invention.

[Drawing 4] It is a block diagram showing the structure of the conventional fuel cell cell.

[Drawing 5] It is a block diagram showing the composition of the conventional fuel cell system.

[Explanations of letters or numerals]

- 1 Polymer electrolyte fuel cell
 - 2 Solid polyelectrolyte membrane
 - 3 Fuel electrode film
 - 4 Oxidant electrode film
 - 5 The separator for fuel gas
 - 6 The separator for oxidant gas
 - 7 Fuel cell cell
 - 8 Cold plate
 - 9 Heat pipe
 - 10 Hydraulic fluid
 - 11 The fin for heat dissipation
 - 12 Bellows
 - 13 Inactive gas
 - 14 Fuel cell system
 - 15 Cooling fan
 - 16 Duct
 - 17 Pump
 - 18 Cooling system
 - 19 Cooling-circulating-water piping
 - 20 Tank
 - 21 Fuel part
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